Abstract

The need for increased product variety and improved aesthetics require the manufacturing enterprise to reduce time to market and to increase use of free-form surfaces in the form of the product. These changes lead to problems in the traditional approach for specification and verification of tolerances especially for a free form surfaces. In the case of freeform surfaces, the desired performance of a product depends on its geometry and is often controlled by intrinsic parameters such as curvature. Design intent therefore requires control on variations in these parameters. Ideally therefore, tolerances have to be applied on these parameters to prescribe allowable variations in the geometry of free-form surfaces. Since only the geometry of the product is controlled in manufacturing, tolerance specification has to ensure that the tolerances specified on the part geometry will ensure that the resulting value of the parameter of interest is within the limits prescribed by the designer. Relationship between allowable range in design parameters and that in geometry is not linear. Tolerance specification therefore becomes a trial and error process requiring considerable expertise and time. This thesis provides designers with a tool to automatically derive the corresponding tolerances to be specified to the manufacturing process to realize the final shape, such that the parameters that are used to control shape of the surface are within the prescribed variations.

Automation in acquiring inspection data has brought dramatic changes in procedure for tolerance verification too. Optical scanners and similar non-contact devices provide large amount of points on the surface of the part quite rapidly. The unstructured point data are then processed to determine if the part complies with the given tolerance specifications. For freeform surfaces, current methods of verification uses minimum distance criterion between the nominal surface and unstructured point data. This ignores the correspondence between the points in the two data sets and may result in the rejection of good parts and acceptance of bad parts. There are other unresolved such as the singularity at corners of polyhedral shapes and handling datum. A new approach based on the Medial Axis Transform (MAT) has been proposed. It has been shown that reasoning

on the MAT of the nominal model and the measured point set respectively enables the identification of corresponding points in the two sets. Verification of the tolerance allocated is therefore free from the problem mentioned above. MAT exhibits dimensional reduction and hence reduces verification time. It also eliminates surface fitting for detected feature.

Results of implementation are provided for tolerance specification and verification using MAT.